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दुरध्वणी : (ईपीएबीएक्स) २६०९००० (अभ्यास मंडळे विभाग- २६०९०९४)
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Estd. 1962
NAAC 'A' Grade
MHRD NIRF-28th Ran

एस.यु./अ.मं./विज्ञान व तंत्रज्ञान विद्याशाखा/10975 दि.31/03/2017

प्रति,

अधिविभागप्रमुख,
गणित अधिविभाग,
शिवाजी विद्यापीठ, कोल्हापूर.

विषय :– एम. फील.पी.एच.डी गणित विषयातील पेपर कमांक तीनच्या अभ्यासकमांबाबत.

महोदय,

उपरोक्त विषयसंदर्भात आपणास आदेशान्वये कळविण्यात येते की, विज्ञान व तंत्रज्ञान एम. फील.पी.एच.डी गणित विषयामध्ये पेपर कमांक तीन साठी खालील विषंयाच्या स्पेशल पेपरच्या अभ्यासकमांना विद्यापीठ अधिकार मंडळाने मान्यता दिली आहे. सोबत अभ्यासकमांची सॉफ्ट कॉपी जोडली आहे.

1. Theory of Fractional Dynamic Systems,
2. Differential and Integral Inequalities,
3. Delay Differential Equations.

उपरोक्त अभ्यासकम शैक्षणिक वर्ष 2016–17 पासून लागू करण्यात आले असुन ते विद्यापीठाच्या www.unishivaji.ac.in या संकेतस्थळावरही उपलब्ध करण्यात आले आहे. तेव्हा सदर बाब सर्व संबंधीत शिक्षक व विद्यार्थ्यांच्या निदर्शनास आणावी.

कळावे,

आपला विश्वासु,

उपकुलसचिव

सोबत :– वरीलप्रमाणे

प्रत :–

1. प्र. अधिष्ठाता, विज्ञान व तंत्रज्ञान विद्याशाखा } यांना माहीतीसाठी
2. पीजीबीयुटीआर विभाग
3. परीक्षक नियुक्ती विभाग } यांना माहीतीसाठी व पुढील योग्य त्या कार्यवाहीसाठी
4. संलग्नता विभाग
5. बी.एस्सी. विभाग

NEW/REVISED SYLLABUS FOR
M. Phil. / Ph.D. Course Work

Paper: III
Title of Paper: Theory of Fractional Dynamic Systems

Unit I: A Short History and Some Related Functions, The R-L Fractional Integrals and Derivatives, The Grunwald-Letnikov Derivative, The Caputo Derivative, The Mean Value Theorem, Dini Derivatives and Comparison Theorems, The Volterra fractional integral inequalities, Fractional Differential inequalities Local Existence and Extremal Solutions, Existence, Uniqueness and Continuous Dependence. **15 Lectures**

Unit II: Approximate Solutions and Global Existence, Linear Fractional Differential Equations, Finite Systems of Differential Inequalities, Existence of an Euler Solution, Caputo's Fractional Differential Equation,Theoretical Approximations-Theoretical and Constructive Existence Result, Generalized Monotone Iterative Technique, Monotone Method for PBVP, Generalized Monotone Iterative Technique- PBVP. **15 Lectures**

Unit III: Quasilinearization,Generalized Quasilinearization, Stability Criteria,Proximal Normal and Flow Invariance,Relation Between Fractional and Ordinary DEs, Lyapunov Theory -Basic Comparison Result, Stability Criteria,Stability Concepts in Terms of Two Measures,Stability Criteria in Terms of Two Measures,Boundedness and Lagrange Stability. **15 Lectures**

Unit IV: Several Lyapunov Functions,Multi-Order Fractional Differential Systems, Stability of Multi-Order Systems via ODEs, Fractional Functional DEs, Fractional DEs Involving Causal Operators, and Fractional DEs in a Banach space, Nonlocal Boundary Value Problems, BVP for Fractional Differential Inclusions, Almost Automorphic Solutions of Evolution Equations.
15 Lectures

Recommended Book(s):

1. V. Lakshmikantham, S. Leela and J. Vasundhara Devi, Theory of FractionalDynamic Systems, Cambridge Scientific Publishers, UK, 2009.

Reference Books:

1. Igor Podlubny, Fractional differential equations. San Diego: Academic Press; 1999.
2. A. Kilbas, H.M. Srivastava, J.J. Trujillo, Theory and Applications of Fractional Differential Equations, Elsevier, Amsterdam, 2006.
3. Kai Diethelm, The Analysis of Fractional Differential Equations, Springer, 2010.
4. L. Debnath, D. Bhatt, Integral Transforms and Their Applications, CRC Press, 2010.

NEW/REVISED SYLLABUS FOR
M. Phil. / Ph.D. Course Work

Paper: III
Title of Paper: Differential and Integral Inequalities

Unit I: Existence and continuation of solutions, Scalar differential inequalities, Maximal and minimal solutions, Comparison theorems, Finite systems of differential inequalities, Minimax solutions, Integral inequalities reducible to differential inequalities, Differential inequalities in the sense of Caratheodory **15 Lectures**

Unit II:,Global existence, Uniqueness, convergence of successive approximations, Chaplygin's method, Dependence on initial conditions and parameters, Variation of constants, Upper and lower bounds, Componentwise bounds, Asymptotic equilibrium, Asymptotic equivalence. Stability criteria, Asymptotic behavior **15 Lectures**

Unit III: The inequalities of Gronwall and Bellman, Some generalizations of the Gronwall-Bellman inequality, Volterra-type integral inequalities, The inequalities of Gamidov and Rodrigues, Simultaneous inequalities, Pachpatte's inequalities, Integro-differential inequalities, Applications-Second order integro-differential equations, Perturbation of Volterra integral equations, Higher order integro-differential equations **15 Lectures**

Unit IV: Nonlinear integral inequalities-Inequalities involving comparison, The inequalities of Bihari and Langenhop, Generalizations of Gronwall- Bellman- Bihari inequalities, Inequalities with Volterra-type kernels, Inequalities with nonlinearities in the integral, Pachpatte's inequalities I, Pachpatte's inequalities II, Integro-differential inequalities, Applications-Second order nonlinear differential equations, Perturbed integro-differential equations **15 Lectures**

Recommended Book(s):

1. V. Lakshmikantham, S. Leela, Differential and integral inequalities -Theory and applications, *Vol-I, Accademic Press, New York London, 1969.*
2. B. G. Pachpatte, Inequalities for differential and integral equations, *Accademic Press, London ,1998.*

Reference Books:

1. E. A. Coddington and N. Levinson, Theory of Ordinary Differential Equations, Tata McGraw-Hill, 1955.
2. B. G. Pachpatte, Integral And Finite Difference Inequalities and Applications, North-Holland Mathematics Studies 205, 2006
3. M. Hirsch, S. Smale and R. L. Devaney, Differential equations, dynamical systems and an introduction to chaos, Elsevier Academic Press, USA, 2004.
4. S. G. Deo, V. Lakshmikantham, V. Raghvendra, Textbook of Ordinary Differential Equations, Tata McGraw-Hill, 1997.

NEW/REVISED SYLLABUS FOR
M. Phil. / Ph.D. Course Work

Paper: III
Title of Paper: Delay Differential Equations

Unit I: Introduction, DDE with Single Constant Delay, DDE with Discrete Delays, DDE with Distributed Delay,DDE with State-Dependent Delay,DDE with Time-Dependent Delay, Constructing the Solution for DDEs with Single Constant Delay, Linear Delay Differential Equation, Numerical Simulation of DDEs, Nonlinear Delay Differential Equations, Salient Features of Chaotic Time-Delay Systems **15 Lectures**

Unit II:Linear Stability Analysis, A Geometric Approach to Study Stability, A General Approach to Determine Linear Stability of EquilibriumPoints **15 Lectures**

Unit III: Bifurcation and Chaos in Time-Delayed Piecewise LinearDynamical System: Simple Scalar First Order Piecewise Linear DDE, Numerical Study of the Single Scalar Piecewise LinearTime-Delay System, Stability Analysis and Chaotic Dynamics of Coupled DDEs

15 Lectures

Unit IV: A Few Other Interesting Chaotic Delay Differential Equations: The Mackey-Glass System, Ikeda Time-Delay System, Scalar Time-Delay System with Polynomial Nonlinearity, Scalar Time-Delay System with Other Piecewise LinearNonlinearities, Time-Delayed Chua's Circuit, Complete Synchronization in Coupled Time-Delay Systems

15 Lectures

Recommended Book(s):

1. M. Lakshmanan, D.V. Senthilkumar, Dynamics of NonlinearTime-Delay Systems,Springer-Verlag Berlin Heidelberg 2010.

Reference Books:

1. Hale, Jack K., Theory of functional differential equations, Springer-Verlag Berlin Heidelberg 1928

2. Hal Smith,An Introduction to DelayDifferential Equations withSciencesApplications to the Life, Springer New York, 2011.